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Investigation of Polymer-70% Aluminum Powder Composite

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Abstract

Metals and polymers permutation in order to produce polymer metals composites attain new fascination and significance to several authors. The first effort to syndicate these two classes of materials was formulated in the earlier years of the 20th era. In this article aluminum flakes were positively assimilated in polyethylene PE matrix to syndicate the valuable properties of metals and polymers. They extend to light weight, endurance to corrosion, brisk fabrication rates and a extensive range of moduli etc. In the current research, differing from 0% to 70% by volume of aluminum flakes were assimilated into polyethylene (PE) matrix by means of mechanical stirring. The impact of filler particle addition on the properties of the composites was identified.

Keywords

Composites, Polymers, Flakes

Introduction

As Composite materials acquire variety of unusual properties; therefore, several types of composite largely used in various industrial fields, for instance automotive, electrical and electronic, aerospace and machine building industries [1-3]. In the past few years various researchers give enormous consideration to likely hoods of use of polymers comprising dispersed conductive fillers, as well as fabrication techniques where polymer metal composites can be prepared [4-8].

In the scope of electrical applications, insulating type of polymer materials poses many pivotal advantages. In every occasion when electrical currents applications needed, polymer materials present ideal contenders in which insulation of high voltages are essential.

Conversely, in some applications wherever polymers deem to be part of absolute equipment which necessitate static accumulation and electromagnetic shielding these gains may become significant disadvantages. Accordingly, forming polymers appropriately conductive is essential to some electrical applications [9-11].

Fabricating composites by integrating powder metals in polymer matrix, would give the permu-

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tations of two constituents metal and polymer to the absolute product. Their properties are appropriate to situations where the release of static electricity, heat conduction, electromagnetic intrusion shields, galvanothermy and changings are the emphasis of consideration [12-15].

These polymer metal composite materials propose lot of gains such as affluence in fabrication, low cost and corrosion resistance facilitate to serve as most conceding materials serving the industrial usage, also the conductivity level can be 'fixed' to fulfill the requirements of the end user.

It's workable to make nonconductive polymer materials conductive by accumulation of various conductive filler metals such as gold, silver, nickel, indium and copper, and carbon black or graphite powder [16,17]. Polymers material can be designed with precise properties customize to every application by considering additives of filler metals. Since electrical conductivity point of view, 10^{-2} S/cm (electrical conductivity) and upper reflect for shielding applications, 10^{-8} to 10^{-2} S/cm for relatively conductive appliance while, in the range of 10^{-12} to 10^{-8} Siemens/cm (S/cm) for electrostatic discharge (ESD) applications [18].

Numerous factors controlling the functioning of conductive polymer metal composites for instance volume, type and conductivity of filler metals enhanced and the selected polymer matrix as well. Polymer metal composites has been studied by many researchers [19-22], these factors are all interconnected and consequently essentially be addressed collectively to yield the most cost-effective material selection and meet the application requirements.

Materials and Methods

Materials

The polymer used in this research was solvent free epoxy primer TIAL P (A) manufactured by IFC Techprocomplect LLC Russian federation, with viscous homogenous black color. Aluminium flakes was provided by MISIS powder metallurgy laboratory with average size of 70-100 µm and 99.5 metal purity.

Sample preparation

Polymer with aluminium metal flakes were mixed together to produce polymer matrix composites by means of mechanical stirring. Using mechanical motor speed of 40 rpm, 70% of aluminium powder were incorporated inside polymer matrix, the internal mixer machine consists of mixing chamber having two counter-rotating rotors and the time of stirring was 15 min after mechanical stirring the composites was left more than 4 hrs. for curing and stabilizing. The composite sample were mechanically cut into appropriate dimension for subsequent testing.

Figure 1: Optical micrograph of polymer -70% aluminium composites.

Results and Discussion

Microstructure

In order to measure and evaluate the microstructure of polymer aluminum composite the sample was horizontally cut to make analyzing for the cross section. As shown in Figure 1 and Figure 2 the aluminum flakes were seen clearly along the surface of the polymer in white color while the polymer appears in a black color. Also, the figure shows the normal distribution of the flakes along with some voids between the two constituents.

Density and electrical conductivity

Observing the aluminum flakes clearly as in Figure 1 and Figure 2 shows the dominance of aluminum through the composites, which increases the electrical conductivity. As aluminum is a proper electrical conductor, hence adding it to the polymer will have a great effect on the properties, how-

Figure 2: Optical micrograph of polymer -70% aluminium composites (more magnification).

ever, all theses properties will be greatly affected by density. The theoretical density for this composite was calculating using Rule of Mixture equation:

$\rho_{theory} = \rho_f V_f + \rho_m V_m$

Where ρ = Density, V_m= Matrix volume fraction and V_f = Filler volume fraction.

The theoretical density of the composites was calculated by the above equation and recorded:

$2.7 \times 70 + 1.2 \times 30 = 225$ gm/cm^3

However, without adding flakes was recorded 120 gm/cm^3

This means aluminum flakes has increased the density of the composites which makes the compound more suitable for use in many devices. Porosity and density one of the major factors controlling the polymer metal composites behavior. Moreover, porosity may affect the electrical conductivity of the produced composites. As, large amount of porosity would prevent the formation of a continuous metal-to-metal network, decreasing the conductivity.

Conclusions

1. The polymer - 70% aluminum composites were scornfully produced by means of mechanical stirring.
2. The microstructure photos show good distribution of aluminum flakes along the polymer matrix.
3. In the optical photos of composites cross section, it has shown clearly the formation of voids.
4. Theoretical density of the composites was increased twice density of the polymer by adding 70% Aluminum flakes.

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